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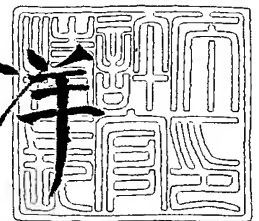
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## PCT REQUEST

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V-1	The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.		
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VIII-1	Declaration as to the identity of the inventor	-	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-	
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IX	Check list	number of sheets	electronic file(s) attached
IX-1	Request (including declaration sheets)	4	-
IX-2	Description	18	-
IX-3	Claims	3	-
IX-4	Abstract	1	✓
IX-5	Drawings	17	-
IX-7	TOTAL	43	
Accompanying items		paper document(s) attached	electronic file(s) attached
IX-8	Fee calculation sheet	✓	-
IX-17	PCT-SAFE physical media	-	✓
IX-19	Figure of the drawings which should accompany the abstract	2	
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X-1	Signature of applicant, agent or common representative		
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10-6	Transmittal of search copy delayed until search fee is paid	✓

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## DESCRIPTION

## ELECTROSTATIC SPRAYING DEVICE

## TECHNICAL FIELD

The present invention relates to an electrostatic device for personal use, and more particularly to a device for spraying a liquid composition by means of an electrostatic force.

## BACKGROUND OF THE INVENTION

WO 03/072263 discloses an electrostatic spraying device having a removable cartridge with a reservoir containing a volume of a liquid composition. The device includes a plunger pump that displaces the liquid out of the reservoir and a nozzle for dispensing the liquid. The nozzle is provided with an emitter electrode which applies a high voltage to the composition being supplied from the reservoir to the nozzle, i.e., electrostatically charge the particles of the liquid composition for spraying the composition by the electrostatic force. The plunger pump disclosed in WO 03/072263 is provided at the rear end of the reservoir on opposite of the nozzle head, which adds an extra dimension to the overall volume of the removable cartridge, and therefore requires a corresponding larger space for the device to accommodate the cartridge. Consequently, when the cartridge is desired to be sufficiently compact to be easily carried with a person, the cartridge is realized only at an expense of reducing a liquid holding capacity of the reservoir. Thus, there remains a need for making the cartridge as compact as possible, while enabling the cartridge or reservoir to hold a sufficient amount of the liquid composition.

None of the existing art provides all of the advantages and benefits of the

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present invention.

#### SUMMARY OF THE INVENTION

The present invention is directed to an improved electrostatic spraying device which is capable of giving an increased liquid containing volume to a removable cartridge, yet keeping the cartridge as compact as possible for enhanced handling performance. The device in accordance with the present invention is configured to electrostatically charge and dispense the liquid composition from a supply to a point of dispense, and includes an actuator, a high voltage generator to provide a high voltage, a power source to activate the actuator and the high voltage generator, a reservoir to contain the supply of the liquid composition, and a dispensing unit. The dispensing unit is provided to spray the liquid composition, and includes a suction pump which is located in immediate upstream relation with the reservoir for supplying the liquid composition from the reservoir, and which is mechanically connected to the actuator to be driven thereby. An emitter electrode is included in the dispensing unit to be electrically connected to the high voltage generator in order to electrostatically charge the liquid composition. Also included in the dispensing unit is a nozzle that is disposed at the point of dispense for spraying the liquid composition.

One characterizing feature of the present invention resides in that the dispensing unit includes a suction pump which is located in an immediate upstream relation with the reservoir for supplying the liquid composition from the reservoir. The pump is mechanically connected to an actuator provided on the side of the device and is caused to operate thereby upon receiving the electric

supply. Thus, the suction pump can be concentrated together with the emitter electrode, enabling a compact design. The reservoir is made deformable according to pressure and/or contents for efficient feeding of the liquid composition by the suction pump.

The pump may be in the form of a gear pump having a pair of gears one of which is formed with a joint for detachable driving connection with the actuator. The gear pump is of an inherently simple structure and contributes to making the pump itself compact. In this connection, the gear pump is incorporated as a pump unit which is shaped into a generally flat configuration. The gears are arranged within the thickness of the pump unit with respective rotation axes perpendicular to a plane of the pump unit. Formed in the pump unit is a horizontal channel extending within the thickness of the pump unit to define an inflow path of the liquid composition from the reservoir to the gear pump as well as an outflow path from the gear pump to the nozzle. Thus, the pump unit adds only a small thickness to the dispensing unit, contributing to making the whole cartridge compact.

The dispensing unit may additionally include a plug to be inserted into a fitment secured at the mouth of the reservoir, so that the reservoir and dispensing unit come into fluid communication. Various configurations of the plug and fitment are possible for providing a detachable or non-detachable connection between the dispensing unit and the reservoir. The reservoir may be shaped to have a planar configuration of an approximate segment of circle defined between a chord and a circumference of an approximate circle which is greater than a circumference of a semicircle, and a mouth provided at the center of the chord. This way, the mouth is located at a position so that the distance from the mouth

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to any point of the circumference of the circle is approximately the same. Thus, the liquid composition can be smoothly sucked up by the pump, thereby minimizing an amount of unconsumed liquid composition.

These and still other features, aspects, and advantages of the present invention will become more apparent from the following detailed explanation of the preferred embodiment when taken in conjunction with the attached drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the invention, it is believed that the present invention will be better understood from the following description of preferred, nonlimiting embodiments and representations taken in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective view of an electrostatic spraying device in accordance with a preferred embodiment of the present invention;

FIG. 2 is a vertical section of the device of FIG. 1;

FIG. 3 is a front view of the device of FIG. 1;

FIG. 4 is a side view of the above device;

FIG. 5 is an exploded perspective view of the above device;

FIGS. 6 to 8 are respectively exploded perspective views of a removable cartridge utilized in the above device;

FIG. 9 is a perspective view of the cartridge of FIG. 8 as viewed from the bottom;

FIG. 10 is a bottom view of the cartridge of FIG. 9;

FIG. 11 is a sectional view of the dispensing unit;

FIG. 12 is a section take along line X-X of FIG. 11;

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FIG. 13 is a perspective view of a main body housing of the device;

FIG. 14 is a perspective view of a metal plate forming a part of the dispensing unit;

FIG. 15 is a partial rear section showing an electrical connection between the dispensing unit and a voltage terminal provided on the side of the housing;

FIG. 16 is a partial vertical section showing the electrical connection between the dispensing unit and the voltage terminal;

FIG. 17 is an exploded perspective view of the housing of the device;

FIG. 18 is a perspective view of the device shown with a front shell of the housing removed;

FIG. 19 is an exploded perspective view illustrating a center frame of the housing, a motor and a high voltage generator mounted on the frame in accordance with the preferred embodiment of the present invention;

FIG. 20 is an exploded perspective view showing the motor and its associated parts accommodated within the housing in accordance with the preferred embodiment of the present invention;

FIG. 21 is a perspective view of the above device with the inner cover removed;

FIG. 22 is a perspective view of the above device shown with the cartridge and an inner cover removed;

FIG. 23 is a vertical section of the device corresponding to FIG. 22;

FIG. 24 is an exploded perspective view of parts forming a field electrode and associated parts of the above device;

FIG. 25 is a perspective view of the above device with an outer cover attached;

FIG. 26 is a vertical section of the above device with the outer cover attached;

FIG. 27 is a plan view of the cartridge;

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FIG. 28 is a front view of a fitment attached to a reservoir of the cartridge;  
FIG. 29 is a cross section taken along line X-X of FIG. 28;  
FIG. 30 is a perspective view of a dispensing unit utilized in the above device in accordance with a preferred embodiment of the present invention;  
FIG. 31 is a side view of the dispensing unit of FIG. 30;  
FIG. 32 is sectional view of the dispensing unit of FIG. 30;  
FIG. 33 is a perspective view of a dispensing unit utilized in the above device in accordance with another preferred embodiment of the present invention;  
FIG. 34 is a rear view of the dispensing unit of FIG. 33;  
FIG. 35 is a side view of the dispensing unit of FIG. 33;  
FIG. 36 is an exploded perspective view illustrating a switch, a selector, and associated parts of the device in accordance with a preferred embodiment of the present invention;  
FIGS. 37A to 37C illustrate different positions of the selector, respectively;  
FIGS. 38 and 39 are block diagrams respectively illustrating the operation of a spraying mode and a dripping mode given to the device; and  
FIGS. 40A to 40C illustrate different positions of a switch for making an analogous function of the selector in accordance with another preferred embodiment of the present invention.

#### DETAIL DESCRIPTION OF THE INVENTION

Now referring to FIGS. 1 to 7, there is shown an electrostatic spraying device in accordance with a preferred embodiment of the present invention. The device is configured into a self-contained portable structure that is compact enough to be easily carried with. The device is basically composed of a main

body housing **10** and a removable cartridge **200** containing a volume of a liquid composition to be electrostatically sprayed according to a mechanism already disclosed in WO 01/12336, WO 01/12335, US 2001-0020653A, US 2001-0038047A, US 2001-0020652A, US 2001-0023902A, and WO 03/072263, incorporated herein by reference. The liquid composition utilized in the device include those disclosed in WO 03/072263, also incorporated herein by reference, i.e., an emulsion having conductive and insulating phases, although not limited thereto.

The housing **10** is dimensioned to be grasped by a user's hand and incorporates an electric motor **30**, a high voltage generator **40**, and a battery **50**, i.e., a power source for activating the motor and the high voltage generator **40**. The motor **30** actuates a dispensing unit **220** provided on the side of the cartridge **200** to dispense the liquid composition, while the high voltage generator **40** applies a high voltage of 1000 volts or more to the liquid composition being dispensed for electrically spraying the liquid composition. The housing **10** is formed with a concavity **12** for receiving a reservoir **210** of the cartridge **200** containing the liquid composition. In a preferred embodiment, an inner cover **20** is detachably fitted over the upper end of the housing **10** to hold therebetween the dispensing unit **220** of the cartridge **200**. In another preferred embodiment, an outer cover **26** is detachably fitted over the inner cover **20** to conceal therebehind the dispensing unit **220** for protection thereof when the device is not in use.

In one preferred embodiment, the cartridge **200** is composed of the reservoir **210** and the dispensing unit **220**. In another preferred embodiment not shown herein, the cartridge is made only of the reservoir.

The reservoir **210** may be suitably made of a plastic material which is deformable according to the contents of the liquid composition. The reservoir **210** may be made by the same resilient material, or combination of a rigid material and resilient material. An example of commercially available material suitable for providing the reservoir is the laminated film of VM-PET (Vacuum Metalised Polyethylene Terephthalate) having a thickness of 12 microns and LLDPE (Linear Low Density Polyethylene) having a thickness of 60 microns. Commercially available films are GLAE by Toppan for VM-PET, and FCS by Tocco for LLDPE. The reservoir may also be made of conductive material and being electrically connected to the high voltage generator so that the liquid composition therein is provided with more or less a common electric potential.

As best shown in FIGS. 6 to 9, in a preferred embodiment the dispensing unit **220** includes a pump **230** and a nozzle **240** which are integrated into a single structure. The pump **230** is a gear pump having a flat base **231** molded from a plastic material and formed with a plug **232** for detachable insertion into a fitment **212** secured to a mouth of the reservoir **210**. The pump **230** includes a metal plate **270** mounted in the base **231** of the molded plastic. The metal plate **270** is formed in its upper surface with a pump chamber receiving a pair of intermeshing gears **234**, an inflow channel **236** extending from within the plug **232** to the chamber, and an outflow channel **237** extending from the chamber to the nozzle **240**. The pump chamber as well as the channels **236** and **237** are sealed by an emitter electrode **250** secured between the base **231** and the nozzle **240**. The gears **234** are arranged to have their individual rotation axes extending perpendicular to the plane of the base **231**, realizing a flat pump structure sufficient to be capable of being disposed between the reservoir **210** and the

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nozzle **240** only at a minimum extra dimension with respect to the height or length of the dispensing unit **220**. One of the gears **234** is coupled to a joint **238** projecting on the lower face of the base **231** for detachable driving connection with the motor **30** disposed within the housing **10**. As the gears are driven to rotate, the liquid composition is sucked up from the reservoir **210** through the inflow channel **236** and expelled through the outflow channel **237** to the nozzle **240**. Preferably, the nozzle **240** is molded from a compatible plastic material as the base **231** to have an internal nozzle pathway **242** extending from the bottom center to an apex **243**, as best shown in FIG. 2.

The emitter electrode **250** is disposed between the base **231** of the pump **230** and the bottom **241** of the nozzle **240** in order to apply the high voltage to and charge the liquid composition being dispensed through the nozzle **240**. In a preferred embodiment, the emitter electrode **250**, which is connected to receive the high voltage from the high voltage generator **40** in the housing **10**, includes a center antenna **251** and a coaxial cylinder **252**. The center antenna **251** extends into the nozzle pathway **242** to charge the liquid composition being dispensed in cooperation with the cylinder **252** that is provided to surround the nozzle pathway **242** to avoid the undesired corona discharging for suitable electrostatic spraying. The top end of the center antenna **251** is receded from the apex **243** of the nozzle **240** to give a sufficient insulation distance therebetween.

As best shown in FIGS. 13 to 16, the metal plate **270** is formed integrally with a pin **254** which projects through the base **231** for detachable electrical connection with a voltage terminal **176** provided on the side of the housing **10** to relay the high voltage to the emitter electrode **250**. Turning back to FIGS. 6 and

7, the emitter electrode **250** also includes a flat bottom **253** that is placed over the base **231** to seal the pump. The flat bottom **253** and the metal plate **270** are cooperative to charge the liquid composition within the pump in order to avoid undesired current flow within the liquid composition in the pump which would otherwise cause deterioration of the liquid composition. As shown in FIGS. 11 and 12, the cylinder **252** is connected to the antenna **251** by a rim **255**. The rim **255** is formed with a plurality of slots **256** that communicate with the outflow channel **237** of the pump for passing the liquid composition from the pump to the nozzle pathway **242**.

As shown in FIG. 17, the housing **10** may be shaped into a generally flat disc, and thus basically composed of a center frame **100**, a front shell **120**, and a rear shell **140** all being molded from a dielectric plastic material and assembled together into a unitary structure to form a front compartment **130** and a rear compartment **150** on opposite faces of the frame **100**, respectively behind the front and rear shells. When taking such generally flat disc shape, the front compartment **130** accommodates therein the motor **30**, the battery **50**, and the high voltage generator **40** which are all supported on the frame **100**, while the rear compartment **150** constitutes the concavity **12** for receiving the reservoir **210**. The frame **100** is formed on its front face with individual sections **103**, **104**, and **105** respectively for mounting the motor **30**, the high voltage generator **40**, and the battery **50**, as shown in FIGS. 18 and 19. The motor **30** is received in the section **103** together with a gearbox **31**. The high voltage generator **40** is composed of a transformer **41** and various electric components mounted on a printed board **80**. The transformer **41** is packed into an insulated module fitted in the section **104**. In that the transformer **41** occupies much more space than

the motor 30 and battery 50, the housing is designed to arrange the transformer 41, the motor 30, and the battery 50 in compact. That is, the transformer 41 is accommodated within the lower part of the front compartment, while the motor 30 and the battery 50 are accommodated within the upper part of the front compartment in side-by-side relation with each other such that the motor and the battery are arranged in stack with the transformer with respect to a vertical axis of the housing 10. The section 105 receives, in addition to the battery 50, a terminal fixture 52 having leads for electrical connection of the battery 50 to the motor 30 and the high voltage generator 40 through a power switch 60 and a control circuit formed on the printed board 80. As shown in FIG. 20, the gearbox 31 includes a reduction gear set 32 through which the motor output is transmitted to an actuator 36 provided for detachable driving connection to the joint 238 of the pump 230 on the side of the cartridge 200. Preferably, the actuator 36 is disposed immediately below a mount 110 formed at the upper end of the frame 100 and is accessible through an opening 112 in the mount 110, as shown in FIGS. 22 and 23. The mount 110 is somewhat recessed for retaining the dispensing unit 220 thereon when the cartridge 200 is attached to the housing 10. The mount 110 is cooperative with adjacent side walls 114 to define a positioning means for the cartridge. Preferably, a pair of hooks 108 is attached on the opposite sides of the frame 100 to constitute a positioning means for detachably holding the inner cover 20 on the housing 10. The hook 108 has a release button 109 which releases the inner cover 20 upon being pressed. As seen in FIGS. 1 and 5, the inner cover 20 may have a flat top 21 formed with a center window 22 through which the nozzle 240 projects when the inner cover 20 is placed over the top half of the housing 10 with the cartridge 200 attached to the

housing 10. The periphery of the window 22 constitutes a retainer ring that holds the flat nozzle bottom 241 on the mount 110 at the upper end of the housing 10. As shown in FIG. 17, the front shell 120 is formed with a window 122 which communicates with the section 105 for replacement of the battery 50. Thus, the battery 50 can be easily replaced by simply removing the inner cover 20 as well as a lid 124 of the window 122. The lid 124 may be eliminated from the device for simplicity.

The rear compartment 150 may be accommodated with a field electrode which surrounds the reservoir 210 to give the same electrical potential to the liquid composition within the reservoir 210 and to the liquid composition within the dispensing unit 220 for keeping the entire liquid composition free from seeing the electric current which would certainly deteriorate the liquid composition.

As best shown in FIGS. 23 and 24, in one embodiment, the field electrode 170 is composed of a first plate 171 and a second plate 172 both made of an electrically conductive metal and shaped to define therebetween the concavity 12 surrounding the entire area of the reservoir 210. The plates 171 and 172 are electrically connected to each other at their peripheries, and are secured to the frame 100 and the rear shell 140. In order to receive the high voltage, the plate 171 is formed to have a lug 174 which extends through the dielectric plate 181 and the frame 100 for electrical connection with a terminal 44 of the high voltage generator 40. The plate 171 is also formed with the voltage terminal 176 in the form of a spring catch for detachable connection with the pin 254 of the dispensing unit 220, as explained hereinabove.

It is noted in this connection that the metal plate 270 and the 250 of the dispensing unit 220 are electrically connected to the field electrode 170 and

therefore act as additional field electrode covering the pump. Also, the metal plate **270** is formed with a metal tube **271** which is inserted into the plug **232** to charge the liquid composition within the plug, and therefore acts also as a further field electrode. Thus, the liquid composition is electrically charged along the entire path from the reservoir **210** to the nozzle **240**. Instead of using the metal tube **271**, it is equally possible to provide an extension which extends from at least one of the plates **171** and **172** and projects outwardly from the concavity to cover the plug **232** and the adjacent part of the dispensing unit.

In a preferred embodiment, when the outer cover **26** is fitted over the housing **10**, as shown in FIGS. 25 and 26, a sealing rubber **27** at the inner upper end of the outer cover **26** comes into contact with the nozzle **240**. The outer cover **26** is also formed with tabs **28** one of which conceals therebehind the power switch **60** to keep the device inoperative. Also, the outer cover **26** conceals the release buttons **109** therebehind to prevent accidental detachment of the inner cover from the housing **10**.

With reference to FIGS. 27 to 29, the cartridge **200** is again explained in details with respect to geometrical configuration of the reservoir **210**. In one preferred embodiment, the reservoir as shown as **210**, is made from a deformable plastic material into a flat bag which has a planar configuration of a segment of an approximate circle and has a mouth to which the fitment **212** is attached. The fitment **212** is molded from a plastic material to have a socket **214** for receiving the plug **232** of the dispensing unit **220**. In detail, the reservoir **210** is shaped into the segment of circle defined between a chord and a circumference of an approximate circle greater than a circumference of a semicircle. The mouth or the fitment **212** is located at a center of the chord such

that the distance from the mouth to any point of the circumference of the circle can be made approximately the same, providing smooth sucking up of the liquid composition from the reservoir and deforming according to the amount of liquid composition left in the reservoir, such that residue left in the end can be kept to a minimum.

In one embodiment, the plug is detachable to the fitment via, for example, a resilient material provided with the fitment. The so-called clean-click-system fitment may be employed for realizing this embodiment. This embodiment is advantageous for providing a cartridge devoid of the dispensing unit, thereby providing an even smaller cartridge.

In the illustrated embodiment of FIG. 25, the fitment 212 is molded to give a first section 215 for welding connection with the reservoir 210 and a second section 216 for welding connection with the plug 232. The first and second sections are molded from different plastic materials so as to be compatible respectively with different plastic materials forming the reservoir 210 and the plug 232, according to their specific requirements. This embodiment is advantageous for providing a secure connection between the dispensing unit and the reservoir.

Other embodiments are possible for providing a secure connection between the dispensing unit and the reservoir. The plug may be molded to give a section for welding connection with the fitment, the section being compatible with the fitment. Alternatively, the fitment and plug may be integrally molded to give a section for welding connection with the reservoir, the section being compatible with the reservoir.

Referring to FIGS. 30 to 32, there is shown the dispensing unit 220 having

the plug **232** detachable to the fitment **212** according to one embodiment of the present invention. The plug **232** is molded integrally with the base **231** to have a first section **261** and a second section **262**. The first section **261** is molded from a plastic material forming the base **231**, while the second section **262** is molded from a plastic material different from that of the base but compatible with the plastic material forming the fitment **212**. Thus, the second section **262** fits easily into the fitment **212** and welded thereto such as by the known ultrasonic welding for secured sealing connection to the reservoir.

FIGS. 32 to 35 show another dispensing unit **220** having the plug **232** which is integrally molded with the fitment **212**. The fitment **212** is inseparably fixed to the plug **232** and is molded from a plastic material compatible with the reservoir for enhanced welding connection of the fitment **212** to the reservoir.

Referring to FIG. 36, the power switch **60** preferably includes a switch knob **61** and a switch contact **62** disposed within a center cavity **126**. The switch knob **61** is held within the cavity **126** by means of a retainer ring **127** to be capable of being depressed against a spring bias, and energizes the motor **30** and the high voltage generator **40** upon being depressed. A light-emitting-diode (LED) **63** disposed in the cavity **126** is energized in response to the knob **61** being depressed to issue a light through a transparent cover **64** for indication of the operation. In a preferred embodiment, the device also includes a selector **70** for selecting one of three modes, i.e., a lock mode for disabling the operation, a spraying mode for enabling the liquid composition to be electrostatically sprayed, and a dripping mode for enabling the liquid composition to be dispensed out of the nozzle without being electrostatically charged. The selector **70** includes a handle **71** which is rotatable around the ring **127** for selecting one of

three positions, i.e., a lock position, a spraying position, and a dripping position, as shown in FIGS. 37A to 37C, respectively defining the above lock mode, the spraying mode, and the dripping mode. In the lock position of FIG. 37A, the handle 71 has its portion engaged with the switch knob 61 to prohibit it from being pressed, thereby disabling the operating of the pump as well as the high voltage generator. The selector 70 also includes tact switches 72 and 73 which are arranged on the printed board 80 to be actuated selectively depending upon the position of the handle 71. In the spraying mode of FIG. 37B, the tact switch 72 is activated such that the pump 230 and the high voltage generator 40 are simultaneously activated upon the switch knob 61 being pressed. In the dripping mode of FIG. 37C, the tact switch 73 is activated such that only the pump 230 is activated upon the switch knob 61 being pressed. Although not clearly seen in the figures, the device may further include an indicator showing which one of the dripping and spraying modes is selected for easy confirmation by the user. Such indicator is preferred to be disposed around the selector handle 71.

The above operation will be explained also with reference to FIGS. 38 and 39. When the tact switch 72 is turned on by the selector handle 71, the pressing of the knob 61 energizes a voltage source 81, a motor controller 82 and at the same time an oscillator 83 for the transformer 41, thereby activating the motor 30 to operate the pump 230, while applying the high voltage to charge the liquid composition. When, on the other hand, the tact switch 73 is turned on by the selector handle 71, the pressing of the knob 61 energizes the voltage source 81 and the motor controller 82 only for operating the pump without applying the high voltage to the liquid composition. Thus, the user can easily drip the liquid

composition by simply manipulating the selector prior to initiating the electrostatic spraying, assuring enhanced convenience of handling the device. The voltage source **81**, the motor controller **82**, and the oscillator **83** are formed on the printed board **80**. Further, the device includes an indicator for indicating which one of the spraying mode and dripping mode is activated. The indicator includes an LED controller **84**, an LED oscillator **85**, and a LED **86**. When the spraying mode is selected at the selector **70**, the LED controller **84** acts to turn on the LED **86**, as shown in FIG. 38, in response to the knob **61** being pressed. When, on the other hand, the dripping mode is selected at the selector **70**, the LED controller **84** drives the LED oscillator **85** to turn on and off the LED **86** intermittently, as shown in FIG. 39, in response to the knob **61** being pressed, thereby providing different visual confirmation to the user for easy distinction between the spraying mode and the dripping mode.

FIGS. 40A to 40C illustrate another scheme of selecting the dripping mode and the spraying mode. In this modification, a tact switch **74** of press-responsive type is cooperative with the switch knob **61A** to constitute the power switch added with the function of the selector. That is, the tact switch **74** gives three positions, i.e., an off position of FIG. 40A, a spray mode position of FIG. 40B, and a drip mode position of FIG. 40C. In the off position, the switch **74** is not actuated to disable the operation of the pump as well as the high voltage generator. When the knob **61A** is pressed to a small extent to correspondingly depress the switch **74**, the spraying mode is selected to energize the pump **230** as well as the high voltage generator **40** for making the electrostatic spraying of the liquid composition. Upon the knob **61A** being pressed to a further extent, the switch **74** is correspondingly depressed to select

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the dripping mode to activate only the pump 230 for dispensing the liquid composition without the electric charge. Thus, the user can easily select the mode by simply varying the pressure applied to the switch knob 61A.

Alternatively, the dripping mode and the spraying mode may be assigned respectively to the depression of the small extent and to that of the further extent.

All documents cited in the detailed description of the Invention are, in relevant part, incorporated herein by reference; the citation of any document is not to be construed as an admission that it is prior art with respect to the present invention.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

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**CLAIMS**

1. An electrostatic device configured and disposed to electrostatically charge and dispense a liquid composition from a supply to a point of dispense, wherein the device comprises:

an actuator;

a high voltage generator to provide a high voltage;

a power source to activate said actuator and said high voltage generator;

a reservoir to contain the supply of said liquid composition; and

a dispensing unit comprising:

a suction pump in immediate upstream relation with the reservoir for supplying the liquid composition from the reservoir, said pump being mechanically connected to said actuator to be driven thereby;

an emitter electrode to electrostatically charge the liquid composition, the emitter electrode being electrically connected to said high voltage generator; and

a nozzle to dispense the liquid composition, said nozzle being disposed at the point of dispense; and

wherein the reservoir is configured to provide a removable cartridge, said reservoir being deformable according to inner pressure.

2. The device as set forth in claim 1, wherein said reservoir is coupled to said dispensing unit and is cooperative therewith to define said removable cartridge.

3. The device as set forth in claim 1, wherein

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said pump is in the form of a gear pump having a pair of gears one of which is formed with a joint for detachable driving connection with said actuator.

4. The device as set forth in claim 3, wherein  
said dispensing unit comprises a pump unit shaped into a generally flat configuration,  
wherein said gears are arranged within a thickness of said pump unit with respective rotation axes perpendicular to a plane of said pump unit,  
said pump unit being formed with a horizontal channel which extends within the thickness of said pump unit to define an inflow path of said liquid composition from the reservoir to the gear pump as well as an outflow path from the gear pump to the nozzle.

5. The device as set forth in claim 1, wherein  
said dispensing unit comprises a plug to be inserted into a fitment;  
said reservoir comprises a mouth for connecting with said fitment;  
wherein the reservoir and dispensing unit are in fluid communication by attaching said plug with said fitment, and said fitment with said mouth.

6. The device as set forth in claim 5, wherein  
said plug is detachable to said fitment.

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7. The device as set forth in claim 5, wherein said fitment is molded to give a first section for welding connection with said reservoir and a second section for welding connection with said plug, wherein said first and second sections are molded from different plastic materials so as to be compatible respectively with the materials forming said reservoir and said plug.

8. The device as set forth in claim 5, wherein said plug is molded to give a section for welding connection with said fitment, said section being compatible with said fitment.

9. The device as set forth in claim 5, wherein said fitment and said plug are integrally molded to give a section for welding connection with said reservoir, said section being compatible with said reservoir.

10. The device as set forth in claim 1, wherein said reservoir is shaped to have a planar configuration of a general segment of circle defined between a chord and a circumference of an approximate circle which is greater than a circumference of a semicircle, said mouth being disposed at a center of said chord.

## ABSTRACT

An electrostatic spraying device has a removable cartridge with a reservoir containing a volume of liquid compositions to be electrically sprayed. The reservoir is deformable according to inner pressure and configured to provide a removable cartridge. The device includes a dispensing unit for spraying the liquid composition. The dispensing unit includes a nozzle for dispensing the liquid composition and an emitter electrode which charges the liquid composition for electrostatically spraying the liquid composition out through the nozzle. A suction pump is integrated into the dispensing unit in an immediately upstream relation with the reservoir for feeding the liquid composition from the reservoir to the nozzle. Thus, the suction pump can be concentrated together with the emitter electrode and the nozzle into the dispensing unit on one end of the reservoir, enabling to realize the cartridge of a compact design.

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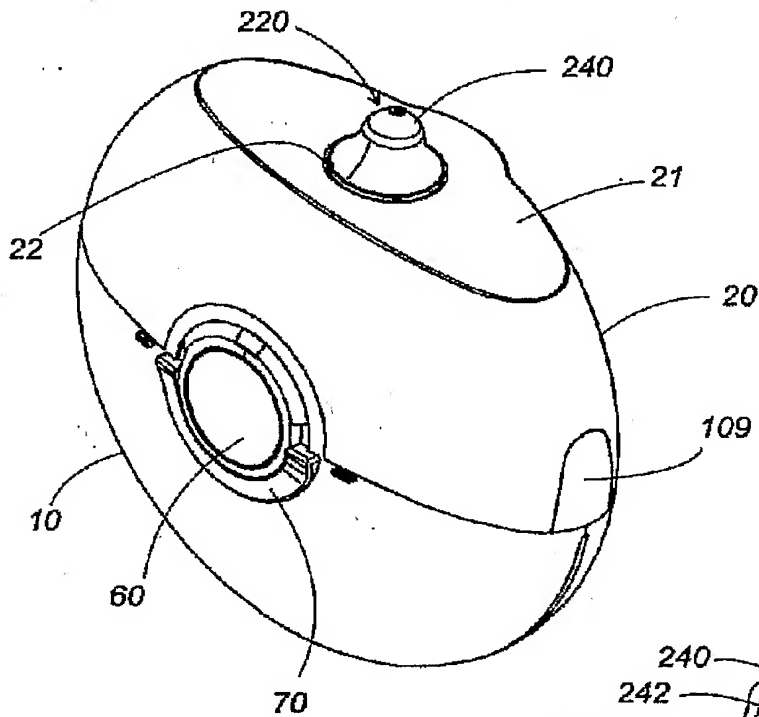
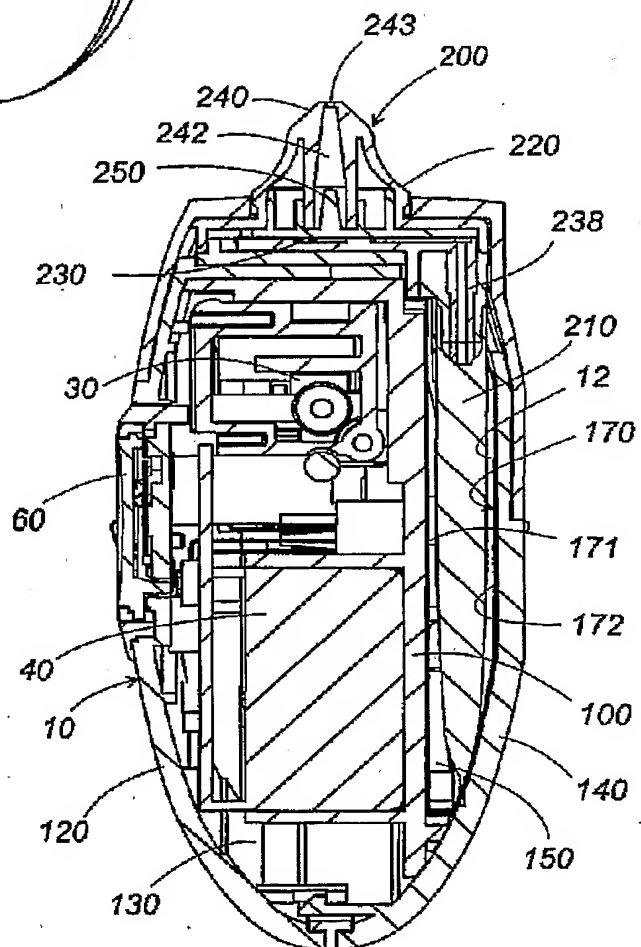


FIG. 1

FIG. 2



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FIG. 3

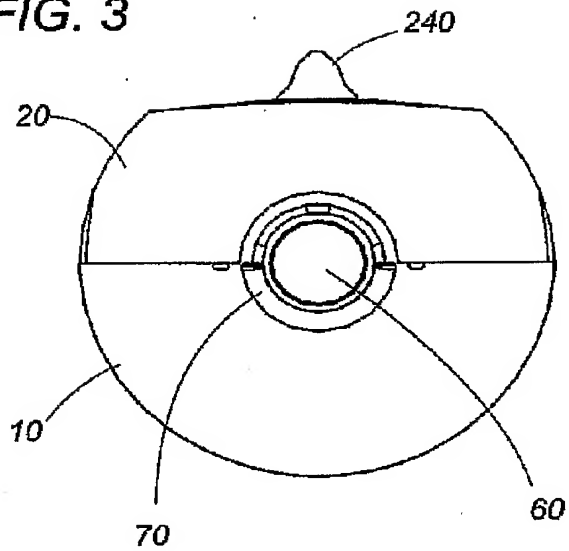


FIG. 4

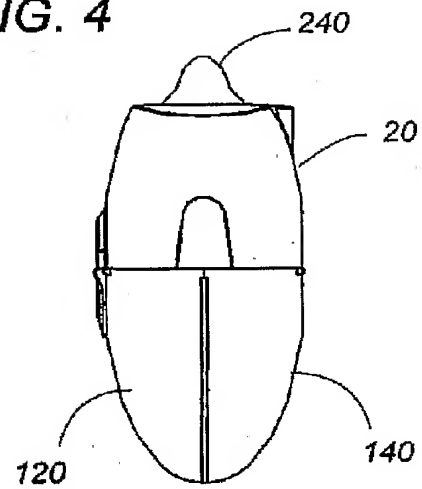


FIG. 5

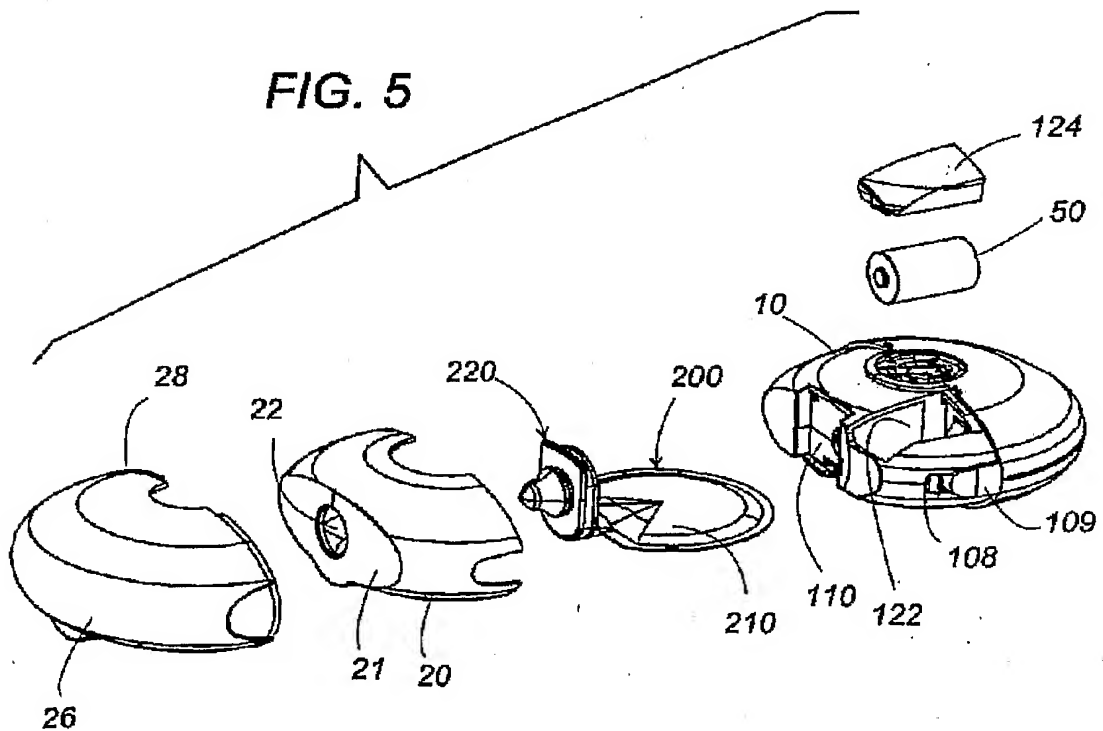


FIG. 6

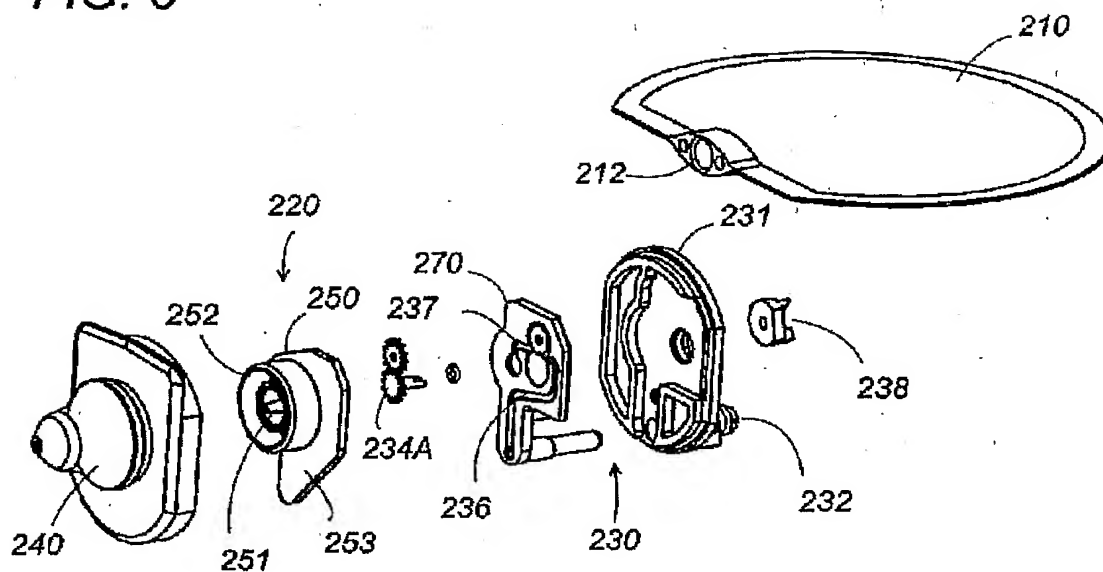
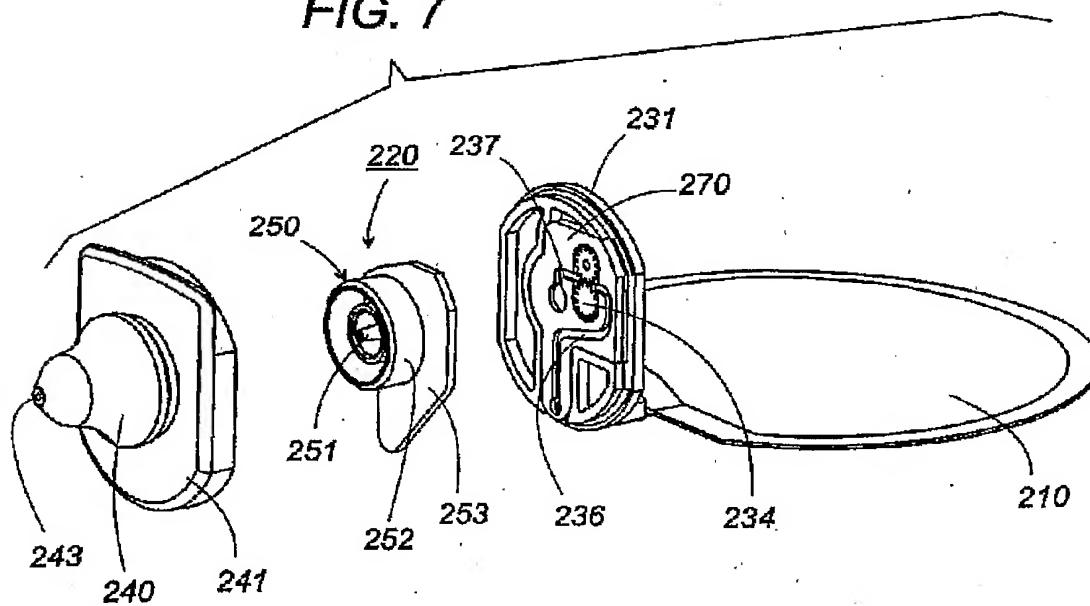


FIG. 7



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FIG. 8

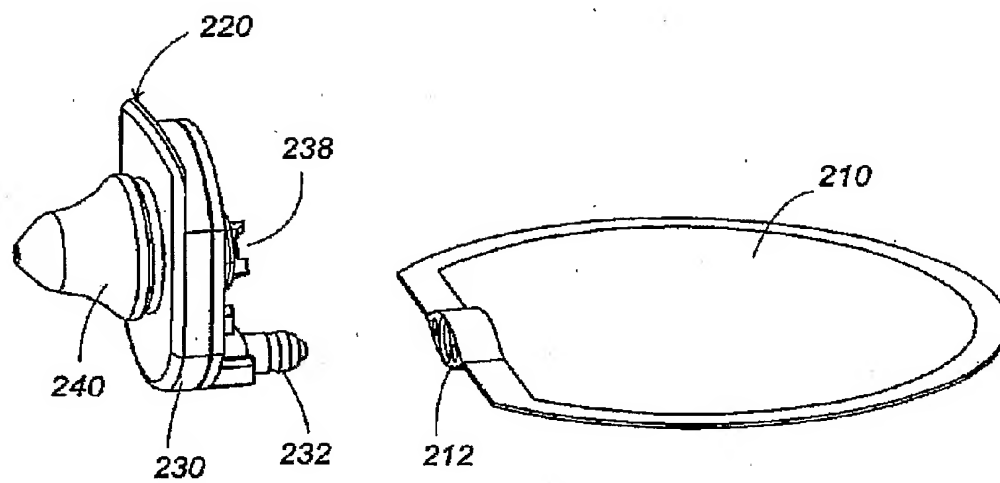


FIG. 9

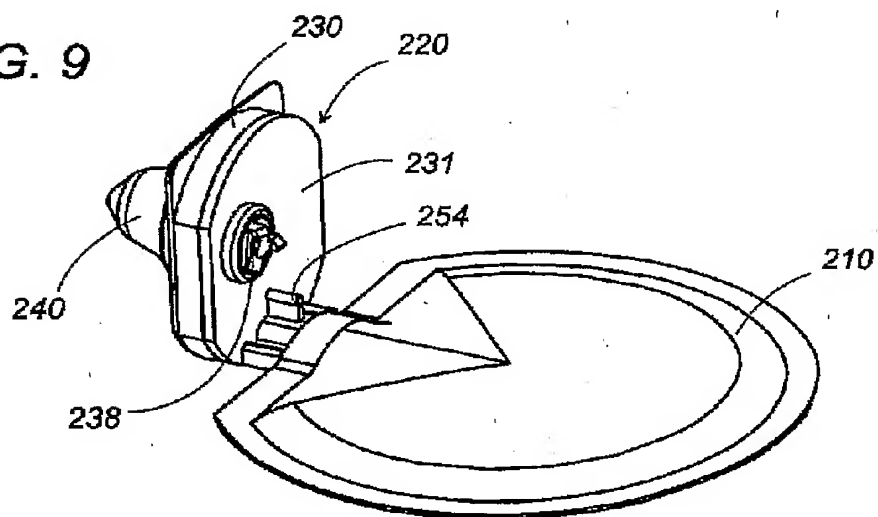


FIG. 10

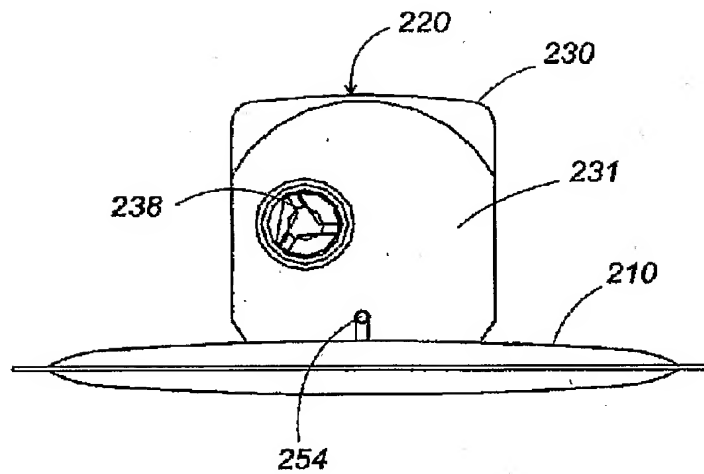


FIG. 11

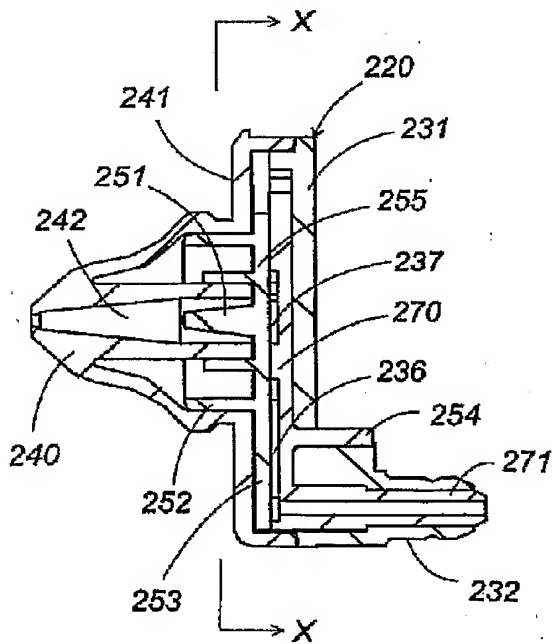
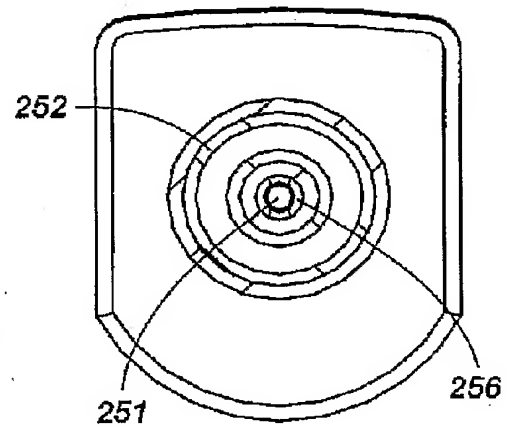


FIG. 12



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FIG. 13

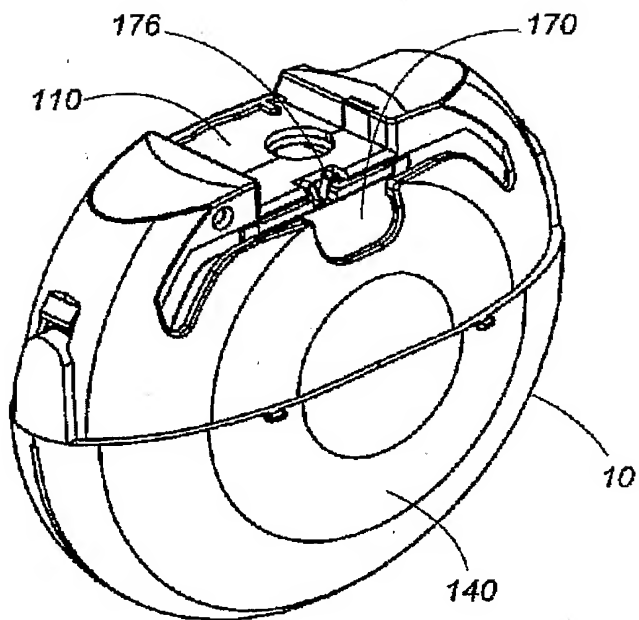
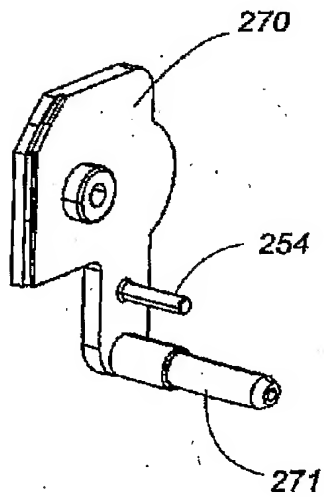


FIG. 14



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FIG. 15

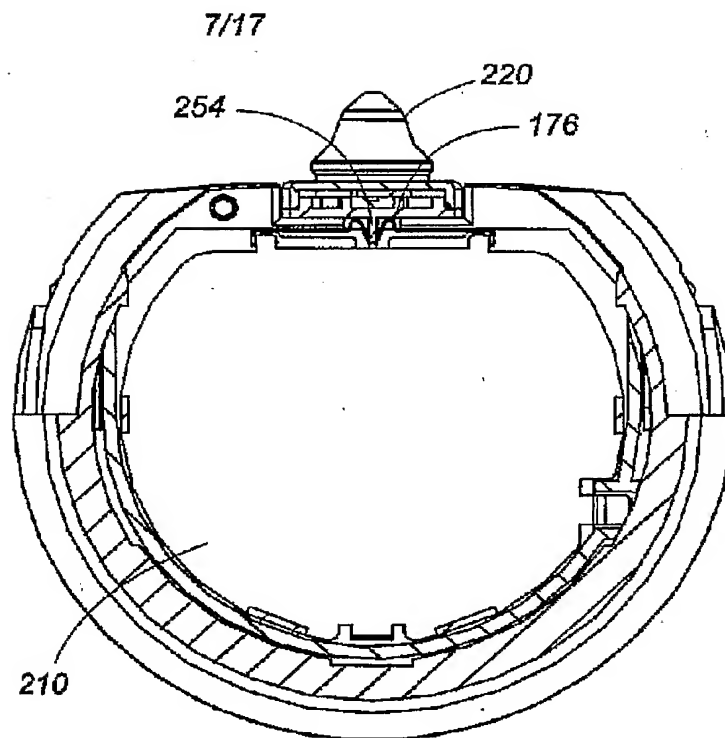
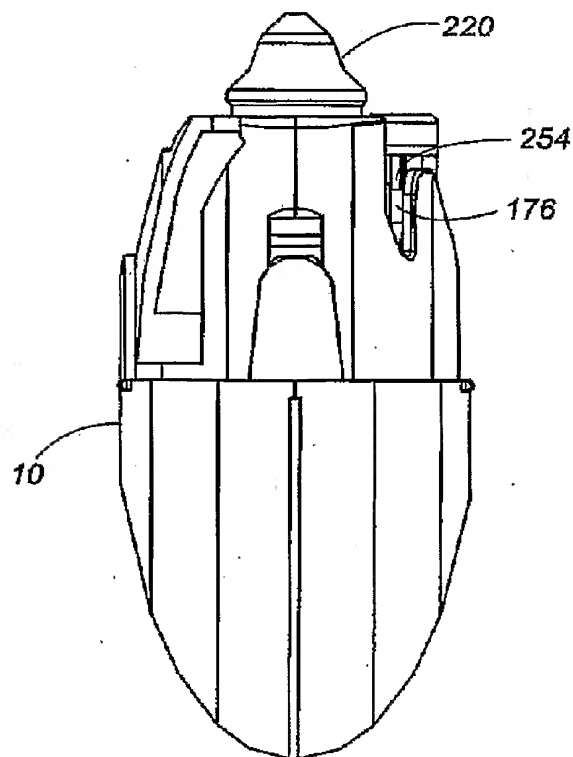


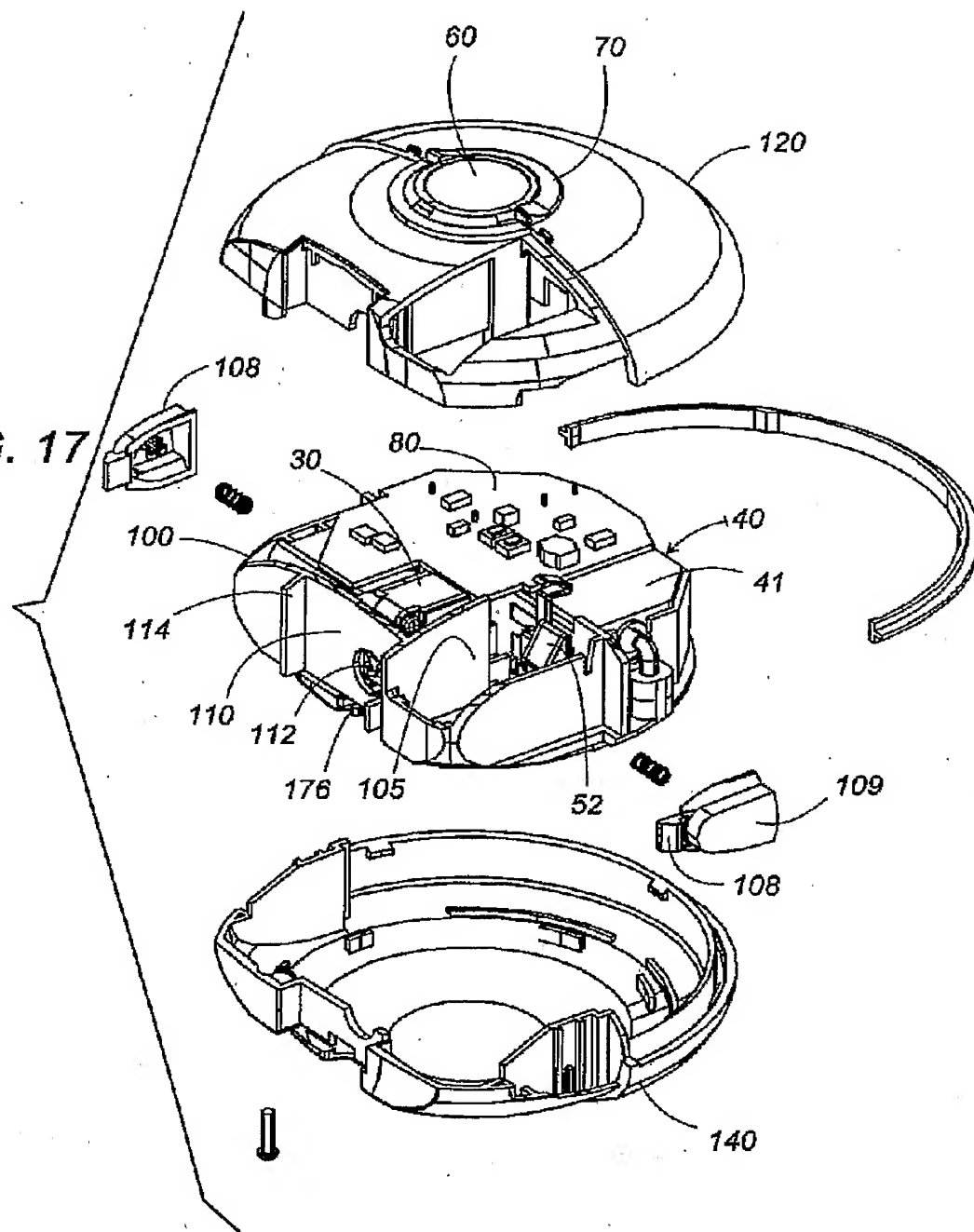
FIG. 16



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FIG. 17



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FIG. 18

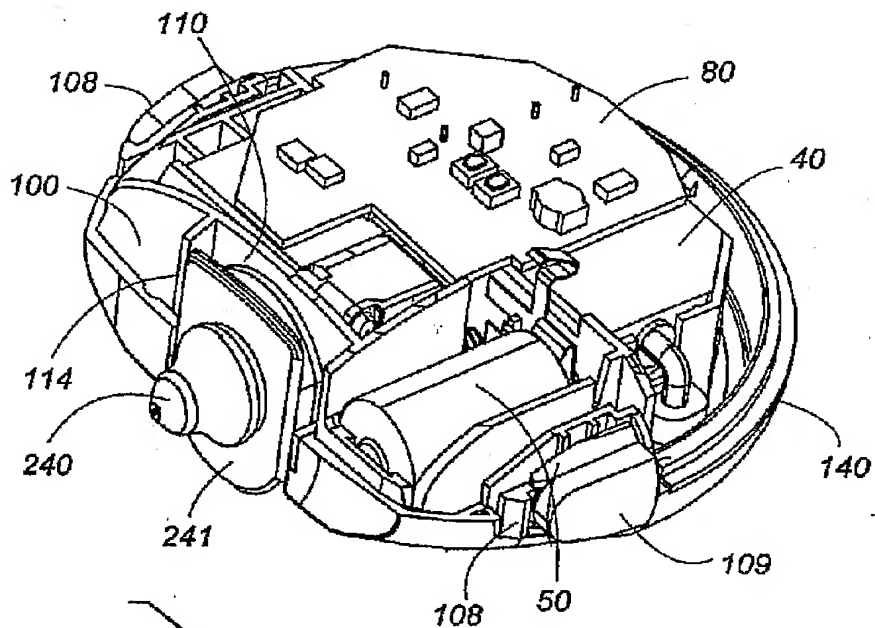


FIG. 19

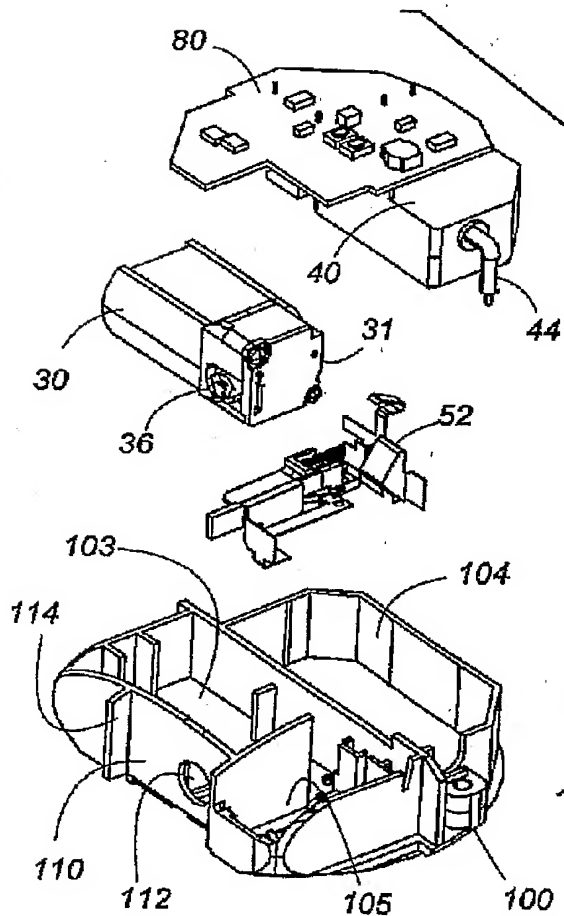
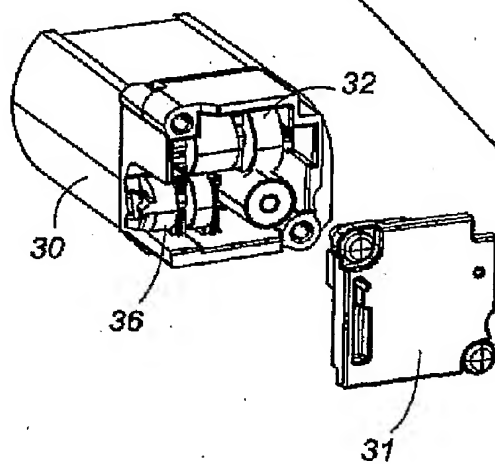
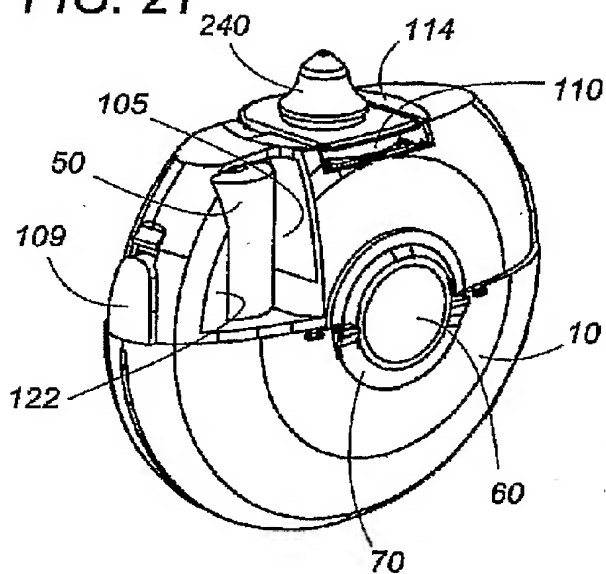
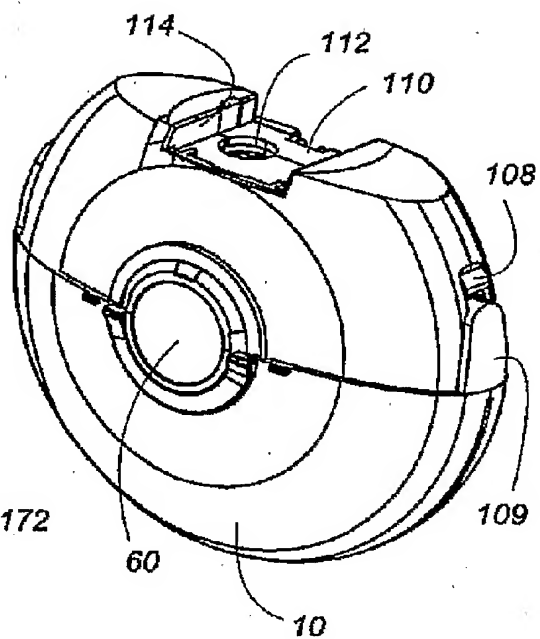
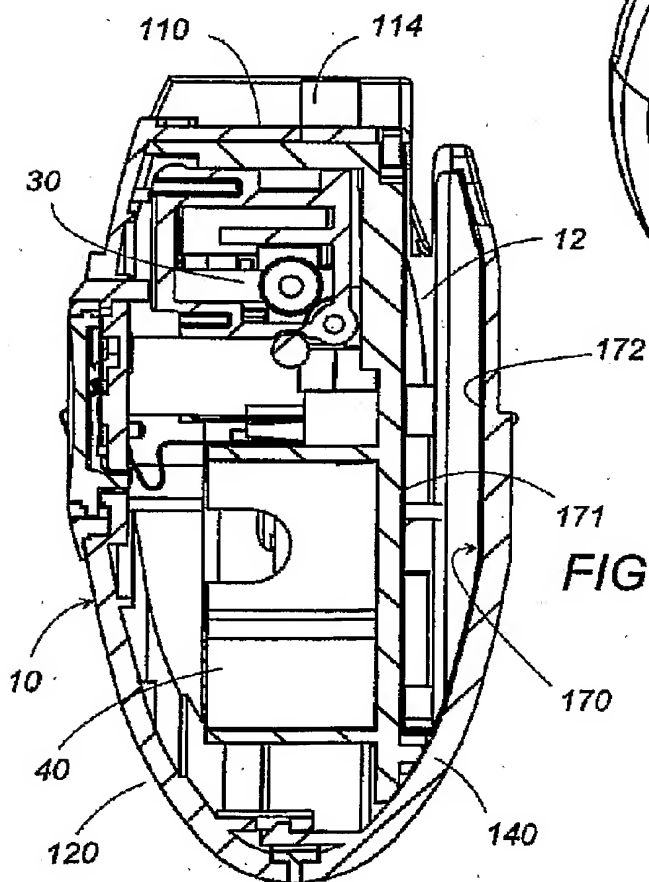


FIG. 20



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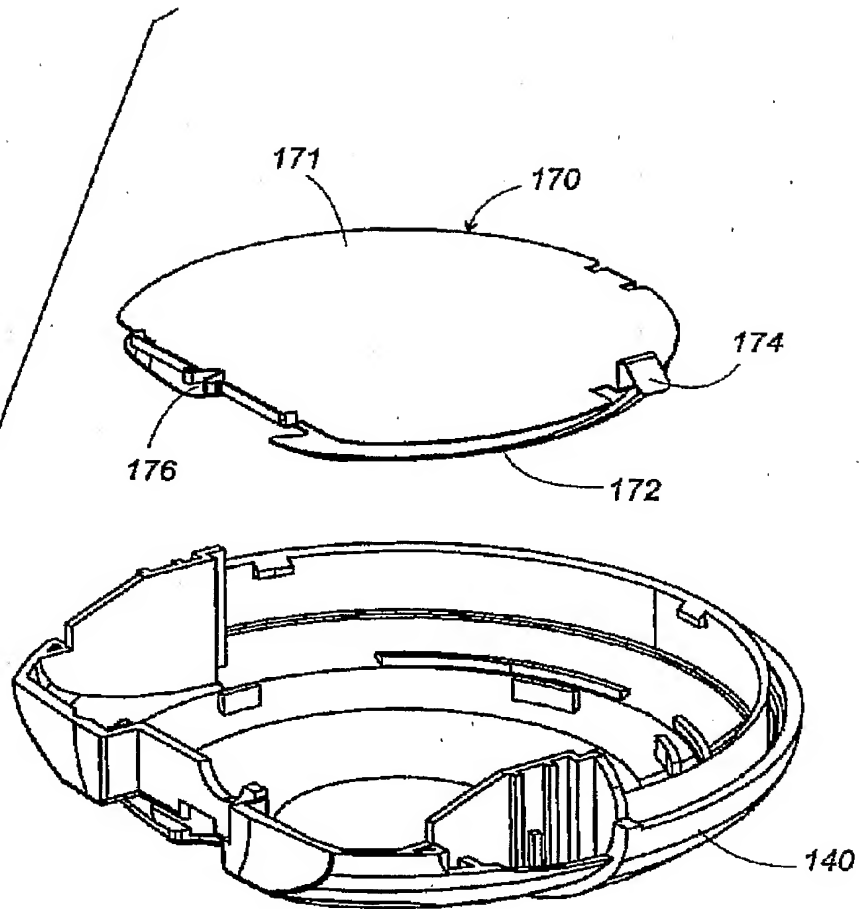
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**FIG. 21****FIG. 22****FIG. 23**

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FIG. 24



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FIG. 25

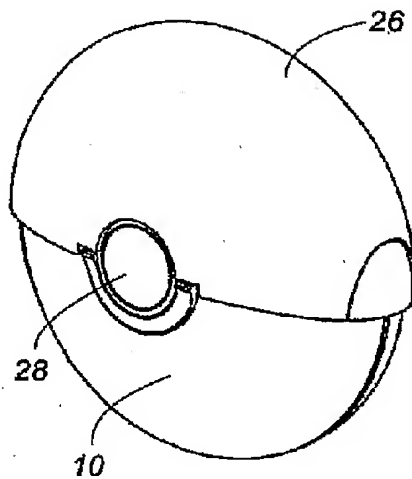


FIG. 26

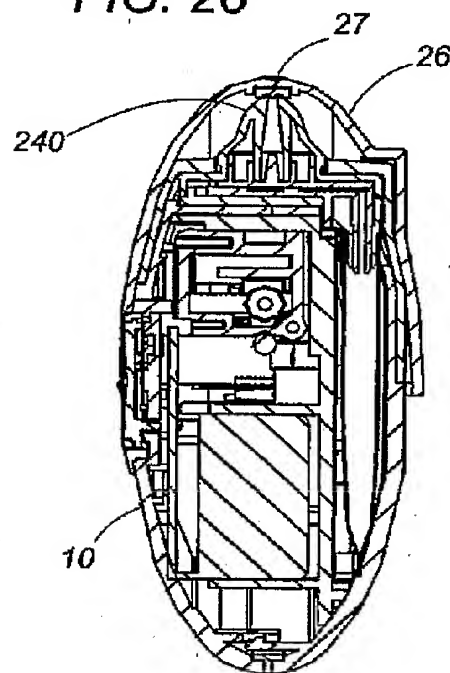


FIG. 27

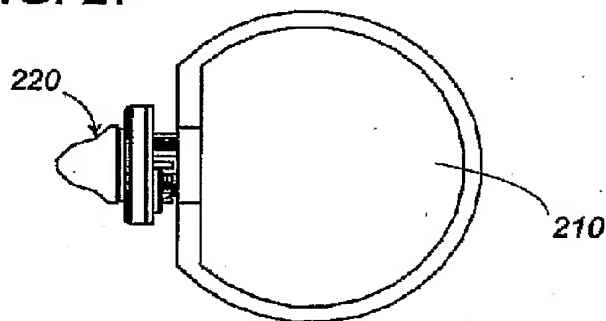


FIG. 28

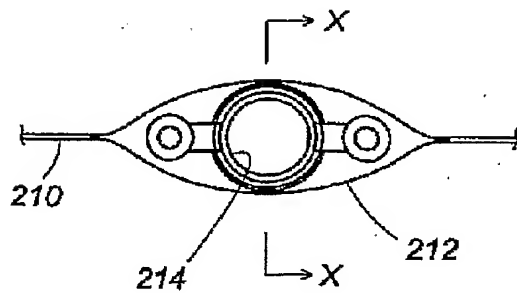
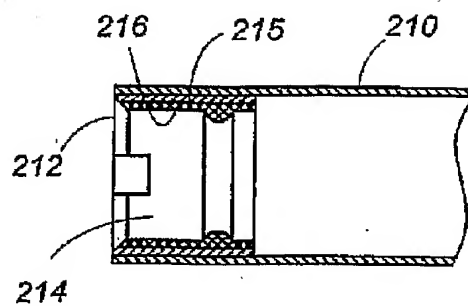
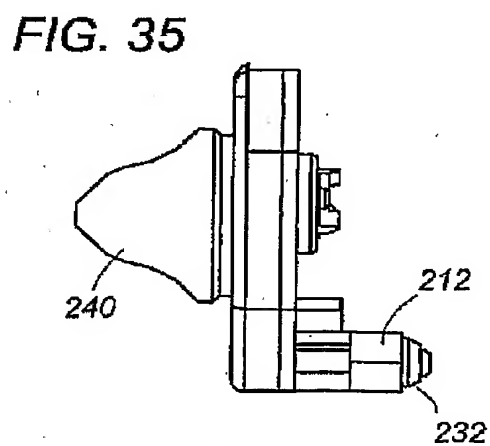
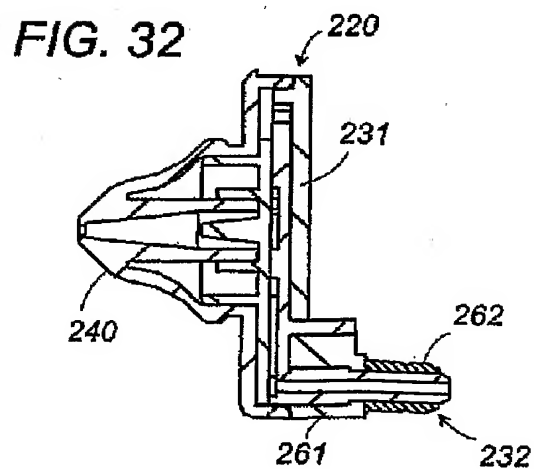
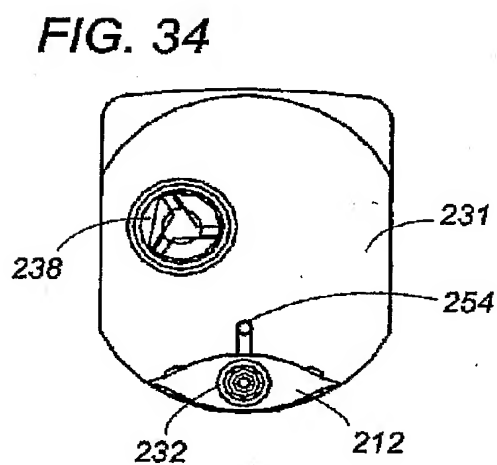
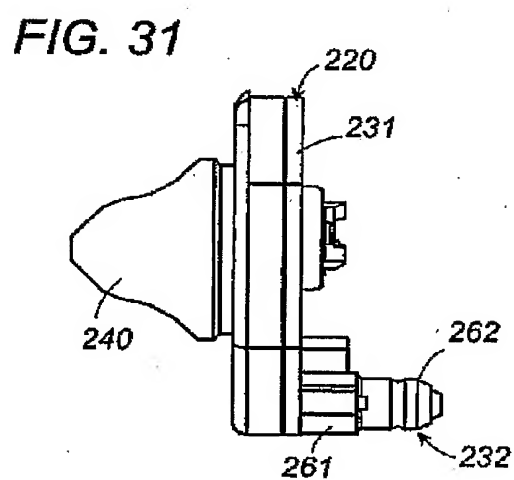
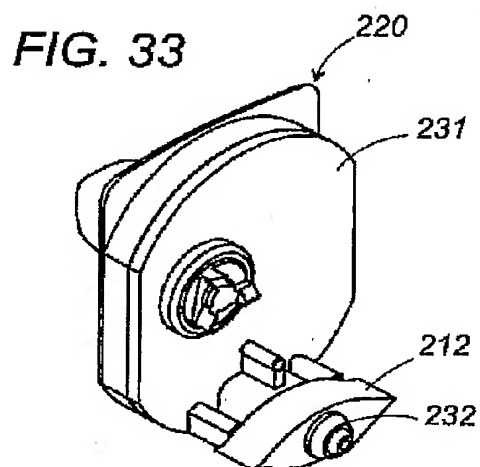
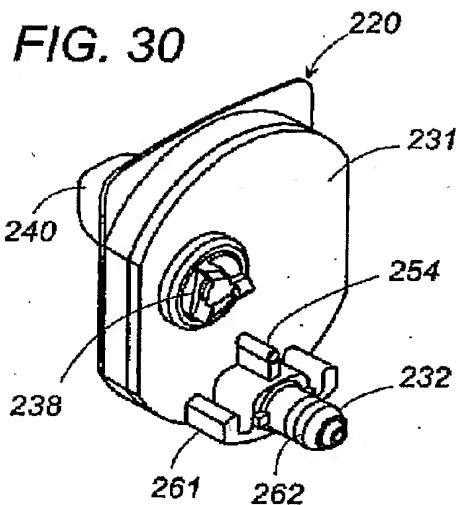


FIG. 29

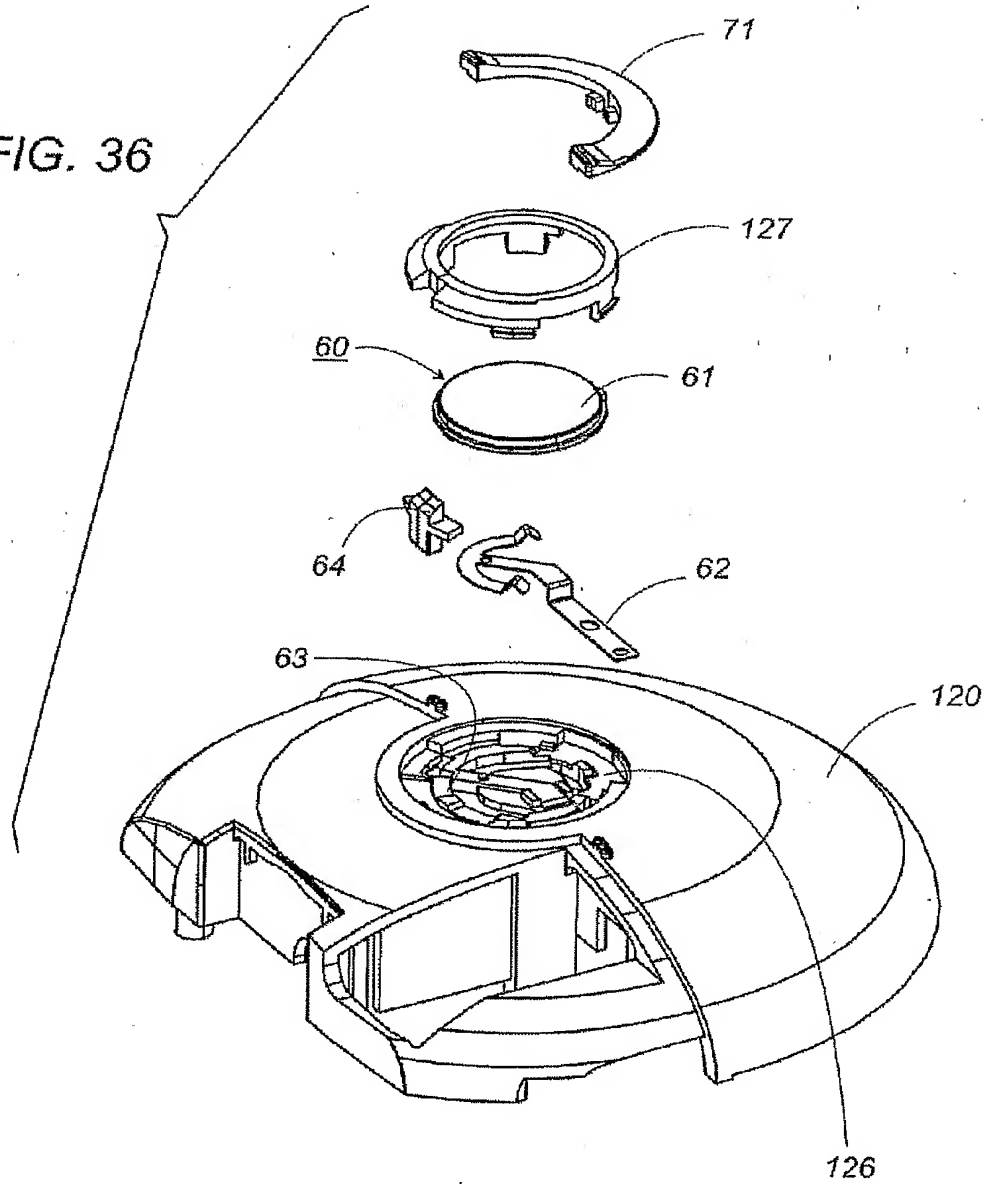




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FIG. 36



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FIG. 37A

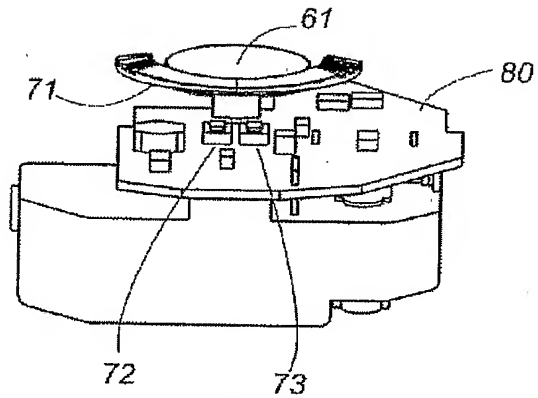


FIG. 37B

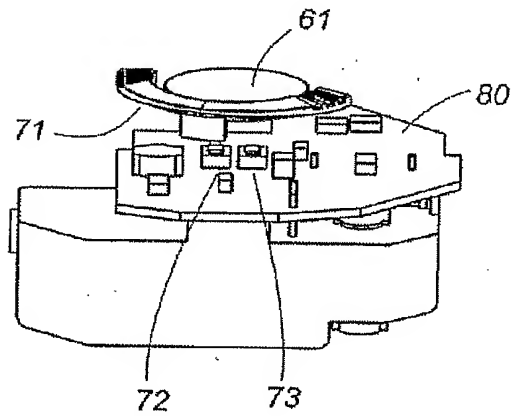
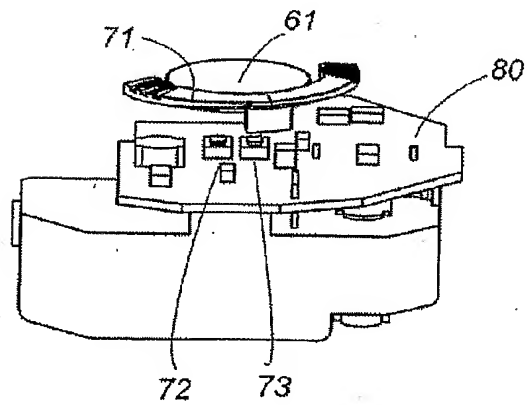


FIG. 37C



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FIG. 38

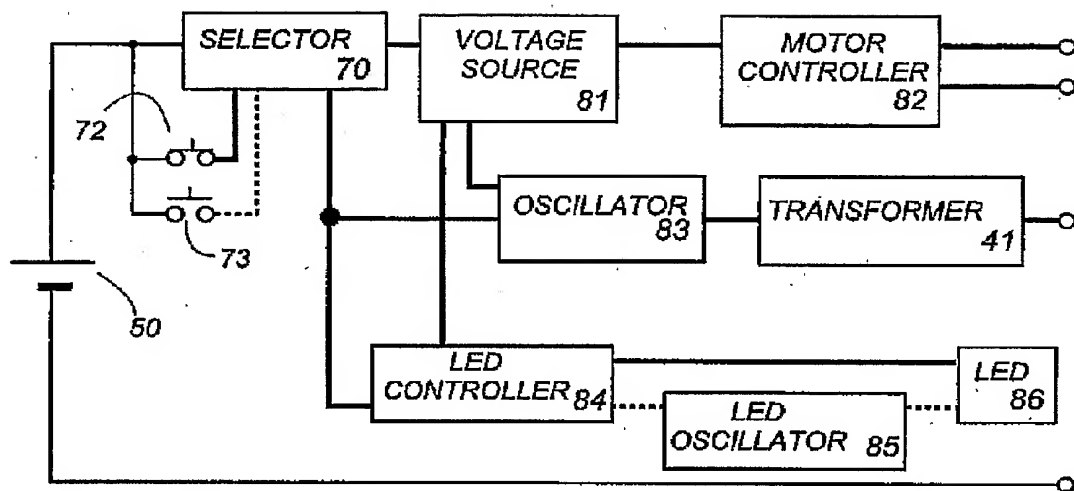
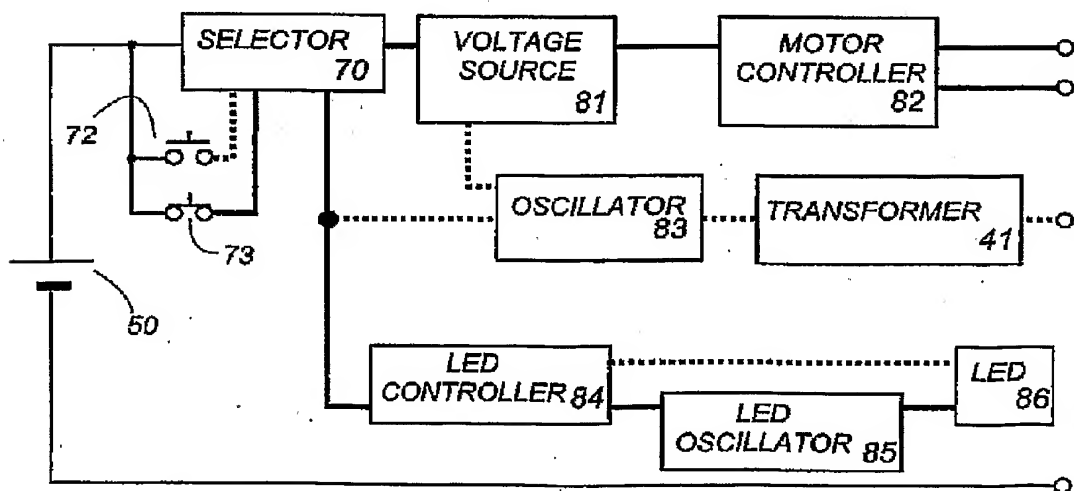


FIG. 39



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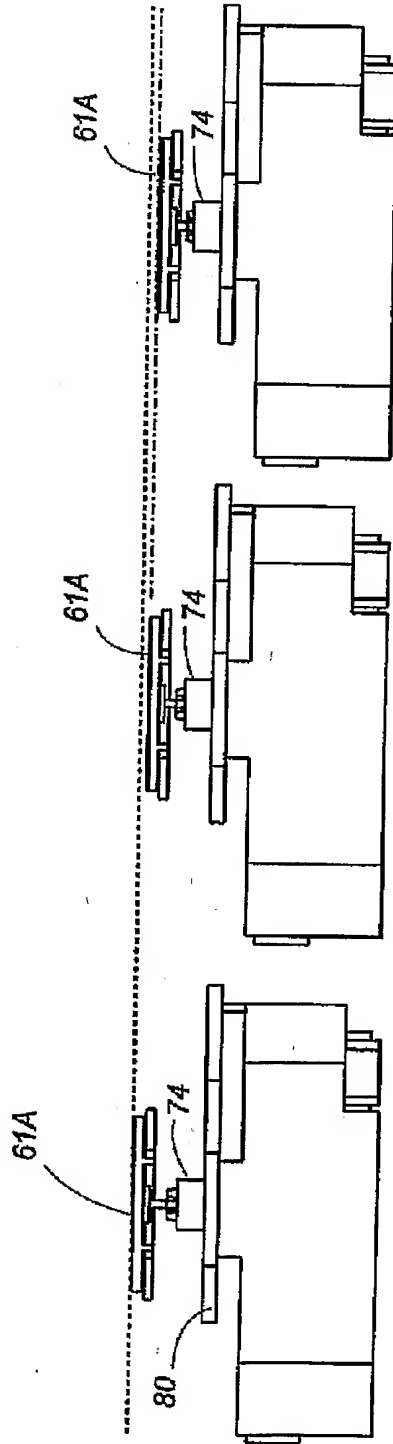


FIG. 40A

FIG. 40B

FIG. 40C